



## Overview of electronic waste (e-waste) management in different enterprises in Alexandria governorate – Egypt

<sup>1</sup>Noha Moustafa Mohamed Kotb, <sup>2</sup>Hesham Zaki Ibrahim, <sup>3</sup>Amel Ibrahim Ahmed

<sup>1</sup>Environmental inspector in Environmental Management Unit (EMU) – Alexandria governorate

<sup>2</sup>Professor of Environmental Studies - Department of Environmental Studies Institute of Graduate Studies and Research - Alexandria University

<sup>3</sup>Associate Professor of Environmental Health - Community Health Nursing Department, Faculty of Nursing - Mansoura University.

### Abstract

Management of e- waste is one of the priority environmental issues. The huge amount of e-waste generated each year from the developed regions has caused a serious challenge in sustainable waste management.

E-waste is defined as a complicated assembly of a number of different materials that cause highly toxic effects to the human health and environment.

Some countries have established systems for the collection, recycling, disposal, and monitoring of e-waste, other countries are still to find a solution for controlling the negative environmental impacts of e-waste.

In Alexandria governorate, limited information is known about the management of e-waste and how to deal and handle it in safe and proper manner especially in different enterprises that generate e-waste. This paper presents and critically analyses the current e-waste management practices in various enterprises in Alexandria governorate to enhance and develop the management strategy of the electronic waste in the future inside enterprises.

Key words: E-waste, types of e-waste, handling of e-waste and waste management.

## Introduction



## 1-1 Definition of e-waste

It means waste that have finished their useful lives , including all components, subassemblies and consumables which are part of the product at the time of discarding.<sup>(1)</sup>

## 1-2 Categorization of e-waste

According to EU directive , electronic waste comprises of ten major categories such as (i) large household appliances, (ii) small household appliances, (iii) information technology and telecommunications equipments, (iv) consumer equipments, (v) lighting equipments, (vi) toys, leisure and sports equipments, (vii) medical devices, (viii) monitoring and control instruments, (ix) automatic dispensers and (x) electrical and electronic tools.<sup>(2)(3)(4)</sup>

## 1-3 Management of waste

Waste management is one of the major environmental concerns in the world. The purpose of waste management system is to make sure that the waste is removed from the source of generation and treated or disposed in a safe manner to minimize environmental problems. The waste management system consists of four main parts: generation, collection, treatment and final disposing.<sup>(5)</sup>

## 1-4 Challenges facing management of e-waste

Lack of infrastructure for the appropriate managing of e-waste. Lack of funds and investment to finance e-waste recycling and treatment facilities which require high initial investments. There is little or no effective enforcement of regulations related to e-waste management and disposal.<sup>(6)(7) (8)</sup>

Increasing of e-waste generated from enterprises creates a need to realize the importance of assessing the fate of e-waste inside different enterprises to enhance the implementation of a policy to deal with e-waste in proper manner.



## Methodology

### Study design:

Cross- sectional study design was used during the the study.

### Setting:

The study conducted at different enterprises that produce electronic waste.

### Subject and study sampling:-

Environmental personal of waste management at different enterprises was the target subject of this study. Sample size was calculated according to Danial 1987 and European Communities 2008  $\alpha=0.5\%$  , Population size= 1455 organizations, Desired precision= 10%, Expected prevalence= 50%, Design effect= 1. The minimum required sample size is 91 organizations.<sup>(9)(10)</sup>

Proportional allocation technique was used to determine the number of enterprises that will be included from each sector. Different industrial enterprises, healthcare and educational organizations were randomly selected. Healthcare enterprises were represented by 4 hospitals out of 34 governmental hospitals, educational organizations represented by 55 organizations out of 884, and finally industrial enterprises represented by 33 industries out of 551 industries.

### Tools:-

Three tools were developed by the researchers to be used during the study; namely. A self administered knowledge questionnaire (Tool 1), actual practice semi-structured interview sheet (Tool 2), observation checklist (Tool 3)

#### **Tool 1: Self administered knowledge questionnaire**

This questionnaire was used to assess knowledge of environmental personal at different enterprises regarding types of e-waste, regulations, and policies of controlling e-waste and methods of managing. Open ended questions were used to avoid guessing.

#### **Tool 2: Actual practice semi-structured interview sheet**

This sheet used to assess the actual practice of different enterprises regarding e-waste management. This sheet includes four main questions about e-waste management team, training strategies, existing plans for managing of e-waste and existing strategies for handling and disposing of e-waste.



### **Tool 3: Observation checklist**

This checklist used to observe the handling of e-waste inside the enterprises including segregation, collection, labeling, transporting, storage and disposing of e-waste.

## **Results and Discussion**

Situational analysis at the studied enterprises includes assessing the knowledge of responsible staff, actual practice regarding managing of e-waste and expectations of e-waste responsible staff were investigated.

### **Situational analysis**

Public environmental awareness is one of the most important indicators that reflect many aspects of environmental status, such as people's knowledge, personal behavior, public capacity, and the local citizens' attitude towards sustainable society as a whole<sup>(11)</sup> The data presented in table (1) and figure (1) revealed that few number of participants were aware about e-waste initiative that conducted in Alexandria governorate by university, governmental and private organizations. The most important e-waste initiatives were conferences, workshops, competitions between students in schools, participation in collection of fluorescent lamps and dispose it in the waste management project located in Nasreya Hazardous Waste Treatment Center (in Alexandria governorate).

Only (12 %) of participants mentioned that their enterprises participated in governmental initiatives, (30.4%) of enterprises participated in private organization initiatives and (28.3%) of enterprises participated in university initiatives.

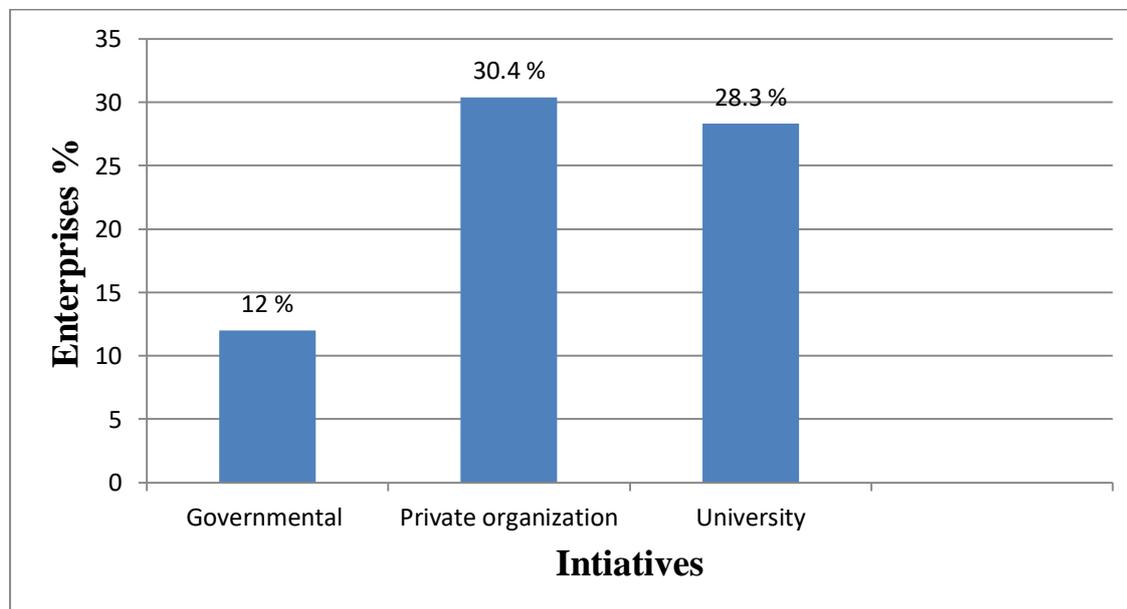
Regarding to their sources of knowledge about e-waste in table (1) and figure (2), the majority of participants (80 %) obtained their knowledge from television, followed by (41.3 %) obtained knowledge about e-waste from newspapers, while (32.6 %) obtained their knowledge from their practical work field, (21.7 %) of participants obtained their knowledge from internet and few of them (10.9 %, 8.7 % and 5.4%) obtained knowledge from scientific periodicals, attending conferences and study field; respectively.

Results of the present study in agreement with the finding of Mallawarachchi and Karunasena (2012)<sup>(12)</sup> in which, most of participants have lack of awareness about e-waste which is considered as a new issue.

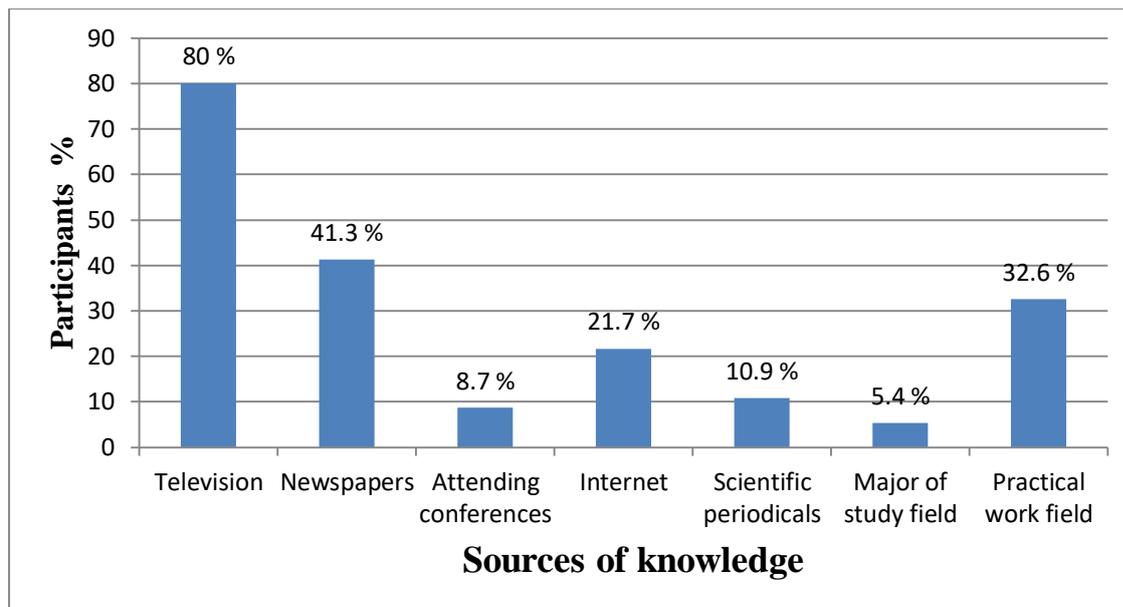


**Table 1 : Distribution of different enterprises according to accurate knowledge about e-waste among responsible staff**

Accurate Knowledge items	Frequency N= 92	%
<b>Knowledgeable about e-waste initiatives</b>		
Governmental initiatives	11	12
Private organization	28	30.4
University	26	28.3
<b>Source of knowledge</b>		
Television	74	80
Newspapers	38	41.3
Attending conferences	8	8.7
Internet	20	21.7
Scientific periodicals	10	10.9
Major of study field	5	5.4
Practical work field	30	32.6



**Figure 1: Knowledgeable about e-waste initiatives**



**Figure 2: Sources of knowledge about e-waste**

The proper definition and identification of electronic waste categories are critical for the sound management of e-waste. <sup>(6)</sup> The WEEE Directive determined 10 broad categories of e-waste (large household appliances - small household appliances- information technology - consumer equipment - lighting equipments - electric and electronic tools - toys, leisure and sports equipment - medical devices - monitoring and control instruments - automatic dispensers). <sup>(13)</sup>

Data presented in table (2) divided into three parts. **In part one:** The data was about the most important types and quantities of e-waste generated from different enterprises; the data revealed that the most important types and quantities of e- waste generated from different enterprises were the lightening equipments especially florescent lamps. The annual quantities generated from (95.6%) of enterprises reported 37050 items.

The second important e-waste items generated from (68.5 %) of enterprises were information technology equipments (computers screens – printers – mouse – key boards – CDs and internal parts in CPU - telephones – faxes machines and other items). The annual quantities were 1414 items.

Several variations in the other types and quantities of e-waste generated from different enterprises, the data reported that 641 items generated annually from (40.2 %) of enterprises. These items were laboratory equipments - control panels.

From only (4.4%) enterprises (hospitals) a large number of e-waste generated. The data reported that 421 items of e-waste generated annually, most of them were medical devices (cardiology devices – dialysis equipments - pulmonary ventilators -laboratory equipments for in-vitro diagnosis – analyzers – freezers).



From (29.3%) of enterprises 246 items of large house hold appliances generated annually, especially (large cooling appliances – refrigerators - large appliances used for conservation and storage of food - conditioning equipments).

From (11.9 %) of enterprises 20 items of electrical and electronic tools (with the exception of large scale stationary industrial tools) were generated including saws - sewing machines - equipments for sawing, cutting, making holes, folding and bending. Finally, small quantities of small household appliances and consumer equipments generated from (5.4%) of enterprises. only 6 items generated annually, most of them were appliances for cleaning-appliances used for sewing, knitting, weaving and other processing for textiles, radio sets, television sets, video cameras, video recorders and audio amplifiers).

**In part two:** Regarding to the presence of e-waste management team, table (2) revealed that few numbers of enterprises (7.6%) have e-waste management team. Only (2.2%) of enterprises their team took training about e-waste abroad.

The data presented in table (2) revealed that the majority of enterprises (96.7 %) have already existing e-waste management plan, the findings of this study in agreement with the findings of Mallawarachchi and Karunasena (2012)<sup>(12)</sup> in which electronic waste management approaches is being implemented in different organizations as a part of an existing waste management policy and the management plan of e-waste still at a primary stage .

**In Part three:** Data was about the implemented items of e-waste management plan at different enterprises. Data in table (2) and figure (3) describes that, the step of collecting discarded electronic equipments present in the majority of enterprises (95.6%) and this step performed by administrative officer who record the name of department and number of discarded items.

In (91.3 %) of enterprises, the responsible of storage room receives the collected e-waste, count each discarded equipments and record it. This results are in agreement with the finding of Mallawarachchi and Karunasena (2012)<sup>(12)</sup> in which some organizations collect and store the damaged electronic equipments.

A trial of segregation of e-waste from other waste started in (30.4%) of enterprises only. this result is similar to findings of Oguchi et al (2012)<sup>(14)</sup> in which the Japanese municipalities started to separate collection and presorting of small WEEE is being implemented.

In (86.9 %) of enterprises, the maintenance and repairing of equipments are first two steps to determine the efficiency of the equipments and availability of reuse it again or use some components of the equipments as spare parts, this results are in agreement with Sothun (2012)<sup>(15)</sup> in which repairing of EEE for reusing purpose is important issues in the guideline of e-waste management in Cambodia.

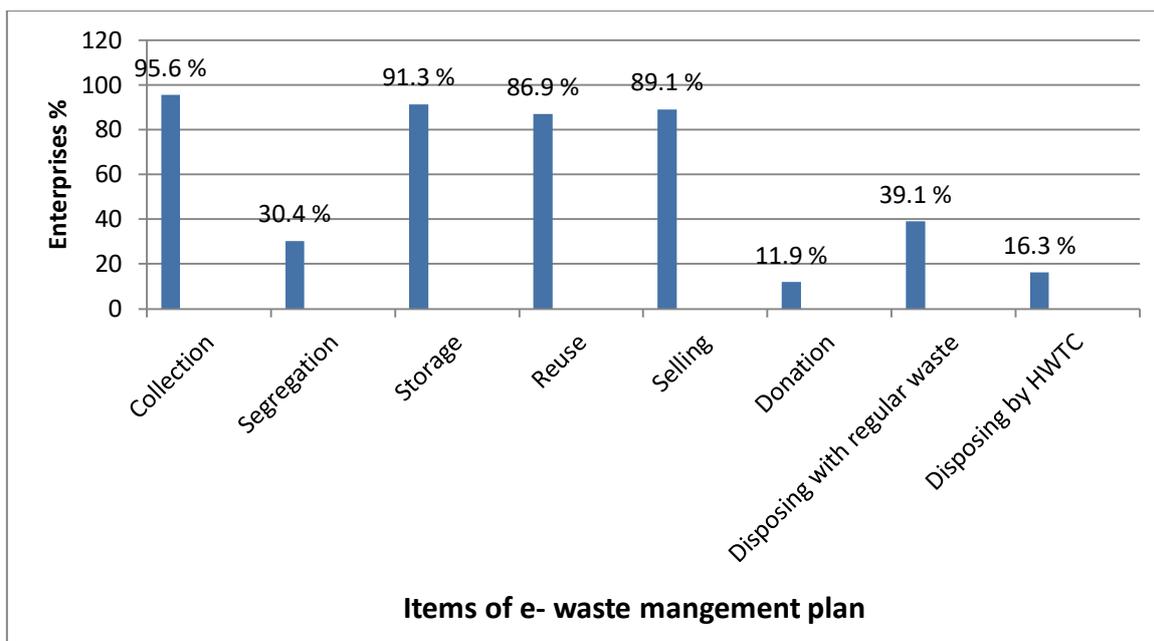


Most of enterprises (89.1%) sell discarded equipments through public auction or sell it to scrap merchant. Few numbers of enterprises (11.9%) donate e-waste to certain bodies as a type of social services. This study's findings in agreement with Huang et al., (2006)<sup>(11)</sup> in which the methods to dispose e-waste are selling of discarded equipments or donating it to other organizations in less developed areas.

Only (39.1 %) of enterprises dispose e-waste with regular waste and (16.3 %) of enterprises contracted with Nasreya Hazardous Waste Treatment Center in Alexandria to dispose e-waste in proper manner especially florescent lamps.

**Table 2: Distribution of different enterprises according to e-waste actual practices as reported by responsible staff members**

Practice items	Frequency N= 92	%	Annual quantities
<b>Types and quantities of generated e-waste</b>			
Large household appliance	27	29.3	246
Small household appliance and consumer equipment	5	5.4	6
Information technology equipment	63	68.5	1414
Lightening equipment	88	95.6	37050
Electrical and electronic tool	11	11.9	20
Medical devices	4	4.4	421
Monitoring and control instruments	37	40.2	641
<b>E-waste management practices</b>			
Presence of e-waste management team	7	7.6	
Training of e-waste management team	2	2.2	
Presence of e-waste management plan	89	96.7	
<b>Implemented items of e-waste management plan</b>			
E-waste collection	88	95.6	
E-waste segregation	28	30.4	
E-waste storage	84	91.3	
E-waste reuse	80	86.9	
E-waste selling	82	89.1	
E-waste donation	11	11.9	
Disposing of e-waste with solid waste	36	39.1	
Disposing by hazardous waste treatment center	15	16.3	



**Figure 3: Implemented items of e-waste management plan inside enterprises**

The waste management process is not so much about technologies of waste treatment and disposal but mainly about the implementation of proper handling, good administration, good organization and the active participation of trained staff .<sup>(16)</sup>

The data presented in table (3) and figure (4) describes the suggestions of participants to improve the actual e-waste management plan inside their enterprises. The data revealed that in (63%) of enterprises, the participants suggested that the implementation of e-waste handling inside enterprises should be in a proper manner to ensure the proper management this type of waste. The handling of e-waste includes collection, segregation, internal transportation, storage and final disposing. This result is in agreement with Mallawarachchi and Karunasena (2012)<sup>(12)</sup> in which e-waste policy need to be enhanced to address issues related to electronic waste collection, storage, treatment and disposal .

From (51.1%) of enterprises, the participants mentioned that the presence of special containers with specific characterization is very important to store this type of waste in proper manner.

Most of participants, from (91.3 %) of enterprises, suggested that especial zone should be presents with a specific lables for storing this type of waste and separating it from any other waste.

Participants, from (63%) of enterprises, suggested that training programs for responsible staff members should be conducted. These programs are about integrated management of e-waste and how to deal with this type of waste inside different enterprises. This result is in agreement with result of Mallawarachchi and Karunasena (2012)<sup>(12)</sup> in which, increasing the levels of awareness about e-waste is important issue in e- waste management.



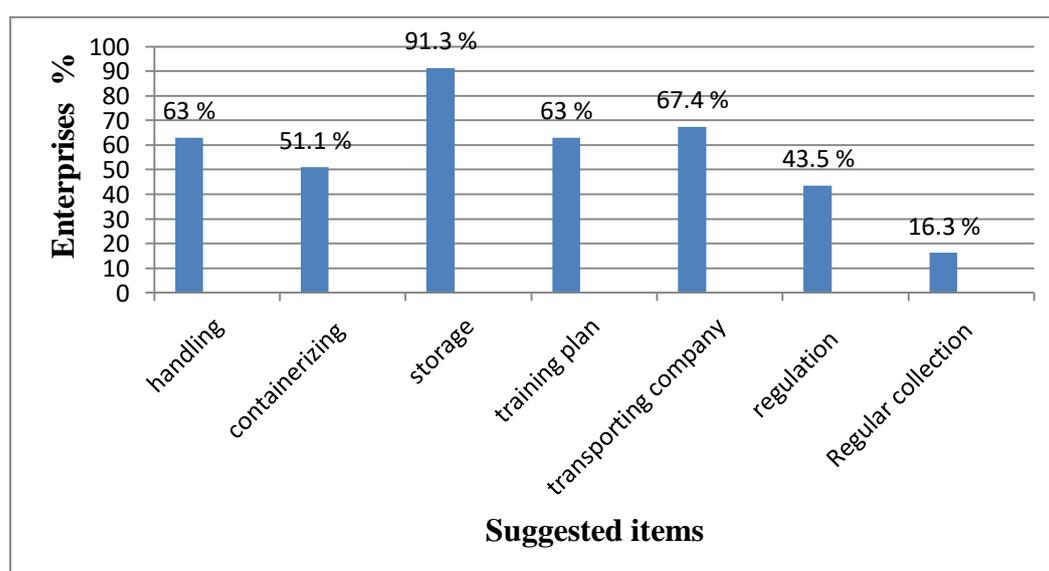
The data revealed that (67.4%) of enterprises their participants agree with findings of Zenga et al. (2012)<sup>(9)</sup> where especial certified waste transporting company should be present to collect e-waste from different enterprises.

The participants, from (43.5%) of enterprises, mentioned that enterprises will not take into account e-waste management without any regulations, laws and legal framework. This findings in agreement with Wath et al (2010)<sup>(17)</sup> in which, the regulatory approach (laws and regulations) should be framed and formulated to restrict the negative impact of e-waste on environment, occupational health and to tackle the ever increasing quantum of e-waste.

Suggestion of participants from (16.3%) of enterprises was about the contraction with specialized agency to collect and transport e-waste regularly from enterprises to prevent the accumulation of this type of waste in storage room. This result in agreement with Zenga et al. (2012)<sup>(4)</sup> in which, consumers have to collect and hand over their own e-waste to certified collectors.

**Table 3: Distribution of different enterprises according to e-waste suggestions as reported by responsible staff members**

Practice items	Frequency N= 92	%
<b>Suggested Items of e-waste management plan</b>		
E-waste handling	58	63
E-waste containerizing	47	51.1
E-waste storage	84	91.3
E-waste training plan	58	63
Contracting with waste transporting company	62	67.4
Presence of regulations and policies for E-waste	40	43.5
Regular collection by specialized agency	15	16.3



**Figure 4: Suggested items of e-waste management plan**



The data presented in table (4) and figure (5) obtained from observed practice of e-waste management inside different enterprises, the data revealed that most of enterprises (90.2%) collected and segregated e-waste from other waste, but all enterprises have not special containers for this type of waste.

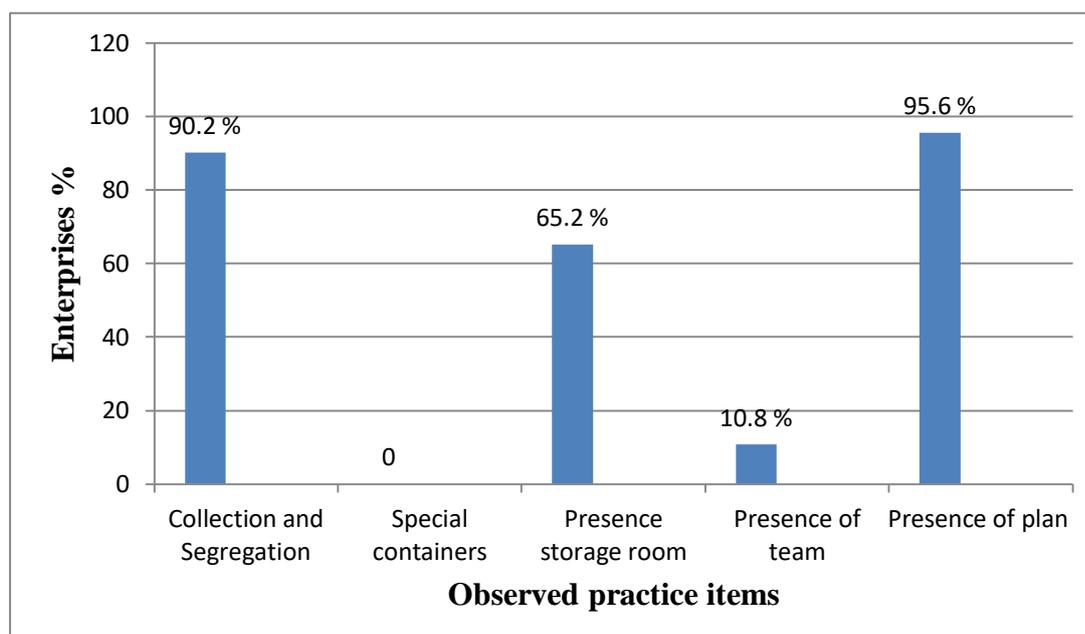
More than half of enterprises (65.2%) have a storage room for all types of waste but there is no especial zone for e-waste.

Only (10.8 %) of enterprises have teams responsible for e-waste management. The team consists of chief administrative officer and the responsible of storage room and the team responsibilities were counting and recording each type of e-waste. There was no specialized person in this field.

Most of enterprises (95.6%) have only administrative plan, this plan limited to count, record and replace the discarded equipments

**Table 4: Distribution of different enterprises according to observed practices of e-waste management**

Observed Practice items	Frequency	%
	N= 92	
Collection and Segregation	83	90.2
Special containers	0	0
Presence of storage room	60	65.2
Presence of team	10	10.8
Presence of plan	88	95.6





### Figure 5: Observed practices items of e-waste management inside enterprises

The data in table (5) presents the participants expectation about the intended developed e-waste management system, the participants of ( 65.2 % ) of enterprises mentioned that developed e-waste system should not has burden on the enterprises because the lack of additional financial resources. This finding is in agreement with Mallawarachchi and Karunasena (2012)<sup>(12)</sup> where a fund should be present to provide financial support to implement electronic waste management processes because most organizations are burdened with financial issues.

Participants from (9.7%) of enterprises mentioned that developed e-waste system should be environmentally sounding, as this system should allow enterprises to dispose their e-waste in a safe manner to prevent the accumulation problem inside enterprises. Also they mentioned that the developed system should be profitable to enterprises

Participants from (29.3 %) of enterprises stated that their enterprises have not any internal rules and regulations regarding electronic waste management and they do not prefer to collect or dispose e-waste without an actual management strategy, so when e-waste mangement system is developed the obligation of enterprises should be take into consideration to ensure the discarding of e- waste by a specialized agency. This finding is in agreement with Sothun (2012)<sup>(15)</sup> in which e-waste management guideline in Cambodia take into consideration national law and regulations.

From (67.4 %) of enterprises, participants ensured that treatment and disposing strategies for e-waste are absent in Alexandria governorate, so the e-waste management system should explain the best methods for disposing this kind of waste. Similar findings were stated by Mallawarachchi and Karunasena (2012)<sup>(12)</sup> regarding the lack of proper procedures on treatment and disposing of collected electronic waste, these procedures should be explained in the national policy of electronic waste management.

**Table 5: Distribution of interviewed environmental personal at different enterprises according to their expectations about the integrated management system for e-waste**

Items	Frequency	%
	N= 92	
Developed e-waste system should not has burden up on the enterprises	60	65.2
Developed e-waste system should profit the enterprises	9	9.7
Developed e-waste system should obligate enterprises to discard e-waste by a specialized agency	27	29.3
Developed e-waste system should explain methods of disposing	62	67.4



This study demonstrated several strength points. Firstly, it assessed knowledge of environmental personal at different enterprises regarding types of e-waste, regulations, policies of controlling e-waste and methods of managing. Secondly, it assessed the actual practices of different enterprises regarding the presence of e-waste management team, training strategies, existing plans for managing of e-waste and existing strategies for handling and disposing of e-waste. Finally, this study depended on the use of the observation checklist to observe the handling of e-waste inside the enterprises including segregation, collection, labeling, transporting, storage and disposing of e-waste.

Moreover, the study estimated the quantities of e-waste that generate from the different enterprises which is very important to know the sectors that generates huge amount of e-waste. Finally, this study described the most important suggested items for managing of e-waste in proper manner and the expectations of the participants in the future about application of e-waste management strategy in Alexandria governorate.

## Conclusion and recommendations

### Conclusion

This study was conducted to asses the current situation about electronic waste management practices inside different enterprises in Alexandria governorate. This study will help the experts to enhance and develop the already existing e-waste management practices.

### Recommendations

- a. Implement awareness and capacity building programs about management of e-waste.
- b. Assist enterprises by donating a fund to establish the management of e- waste.
- c. Determine the most important sectors that generate huge amount of e-waste by conducting further studies.
- d. Enhance the existing e-waste management plan in different enterprises through the experts and governmental assistants
- e. Submit the results of this study to the authorized organizations in Alexandria Governorate.



## References

- 1) Kaya I. (2012). Evaluation of outsourcing alternatives under fuzzy environment for waste management. **Journal of Resources, Conservation and Recycling**. 60:107–118.
- 2) Coby S.C. W., Duzgoren-Aydin N. S., Aydin A., Wong M. H. (2007). Evidence of excessive releases of metals from primitive e-waste processing in Guiyu, China. **Journal of Environmental Pollution**.148: 62-72.
- 3) Ongondo F.O., Willims I.D. , Cherrett T.J. (2011). How are WEEE doing? A global review of the management of electrical and electronic wastes. **Journal of waste management**. 31: 714-730
- 4) Zeng X., Li J., Stevels A.L.N., Liu L. (2013). Perspective of electronic waste management in China based on a legislation comparison between China and the EU. **Journal of Cleaner Production**. 51:80-87.
- 5) Demirbas A. (2011). Waste management, waste resources facilities and waste conservation process. **Journal of Energy Conservation and Management**. 52, (2):182-187.
- 6) Herat S., Agamuthu P. (2012). E-waste: a problem or an opportunity? Review of issues, challenges and solutions in Asian countries. **Journal of Waste Management and Research**. 30 :1113- 1129



- 7) Osibanjo O., Nnorom I. C. (2007). The challenge of electronic waste (e-waste) management in developing countries. **Journal of Waste Management & Research**. 25: 489–501
- 8) Bhutta M. K. S., Omar A., Yang X. (2011). Electronic Waste: A growing concern in todays. **Journal of Environment Hindawi**. 2011:1-8
- 9) Danial W. W. (1987). Biostatistics: a foundation for analysis in health sciences. 5<sup>th</sup> edition, John Wiley & Sons., ISBN 0-471-52514 P. 1571
- 10) Survey sampling reference guidelines: Introduction to sample design and estimation techniques. (2008).
- 11) Huang P., Zhangand X., Deng X. (2006). Survey and analysis of public environmental awareness and performance in Ningbo, China: a case study on household electrical and electronic equipment. **Journal of Cleaner Production**.14: 1635-1643
- 12) Mallawarachchi H., Karunasena G. (2012) Electronic and electrical waste management in Sri Lanka: Suggestions for national policy enhancements **journal of Resources, Conservation and Recycling**. 68: 44– 53
- 13) Khetriwal D. S., Widmer R., Kuehr R., Huisman J. (2011). One WEEE, many species: lessons from the European experience. **Journal of Waste Management & Research**. 29: 954 - 962
- 14) Oguchi M., Sakanakura H., Terazono A., Takigami H. (2012). Fate of metals contained in waste electrical and electronic equipment in a municipal waste treatment process. **Journal of Waste Management**. 32: 96–103
- 15) Sothun C. (2012). Situation of e-waste management in Cambodia. **Journal of Procedia Environmental Sciences**. 16: 535 – 544
- 16) Botelho A. (2012). The impact of education and training on compliance behavior and waste generation in European private healthcare facilities. **Journal of Environmental Management**. 98 : 5-10
- 17) Wath S. B., Vaidya A. N., Dutt P.S., Chakrabarti T. (2010). A roadmap for development of sustainable E-waste management system in India. **Journal of Science of the Total Environment**. 409: 19- 32



## نظرة عامة على إدارة المخلفات الإلكترونية في المنشآت المختلفة بمحافظة الإسكندرية – مصر

مقدم من

الدكتورة /نهى مصطفى محمد قطب

مفتش بيئة بإدارة شؤون البيئة بديوان عام محافظة الاسكندرية

الاستاذ الدكتور/هشام زكى إبراهيم

أستاذ الدراسات البيئية – قسم الدراسات البيئية

معهد الدراسات العليا و البحوث – جامعة الاسكندرية

د. أمل إبراهيم أحمد

أستاذ مساعد بصحة البيئة - قسم صحة البيئة

كلية التمريض – جامعة المنصورة

### الملخص

تعد إدارة المخلفات الإلكترونية واحدة من أهم القضايا البيئية ذات الأولوية في مختلف البلدان ، و تشكل الكميات الهائلة من المخلفات الإلكترونية التي يتم توليدها سنوياً تحدياً خطيراً للإدارة المستدامة للنفايات.

المخلفات الإلكترونية هي تجمع معقد لعدد من المواد المختلفة ، كثير منها شديد السمية لصحة الإنسان والبيئة. و لذلك فإن بعض البلدان لها أنظمة مختلفة لجمع المخلفات الإلكترونية وإعادة تدويرها والتخلص منها ، ولا تزال بلدان أخرى تبحث عن حل للتحكم في الآثار البيئية السلبية الناتجة عن الإدارة الغير سليمة لهذه المخلفات.

أما بالنسبة للوضع في محافظة الإسكندرية ، تُعرف معلومات محدودة عن إدارة المخلفات الإلكترونية وكيفية التعامل معها ومعالجتها بطريقة آمنة خاصة في المنشآت المختلفة التي تولد المخلفات الإلكترونية. لذا فمن المهم جداً تقييم الوضع الحالي لنظام إدارة المخلفات الإلكترونية داخل المنشآت المختلفة للوقوف على أهم الممارسات الخاطئة لمحاولة معالجتها مستقبلاً . تعرض هذه الورقة وتحلل بشكل دقيق الممارسات الحالية لإدارة المخلفات الإلكترونية في مختلف المنشآت بمحافظة الإسكندرية.